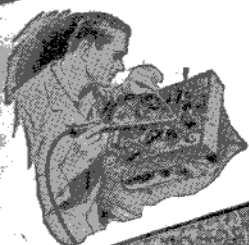


How to Make Extra Money **FIXING RADIOS**

NATIONAL RADIO INSTITUTE, WASHINGTON D. C.

No. 9 How To Test and Replace
Coils, Chokes, and Transformers
RADIO SERVICING METHODS



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I certainly am pleased with the NRI Course. I started to earn profits at about my twentieth lesson, and averaged about \$15 a week during my training. The NRI experiments helped me a lot in servicing radios. At present I am doing spare time repair work in my home. My profits for the past year were about \$400. I intend to open my own shop soon.

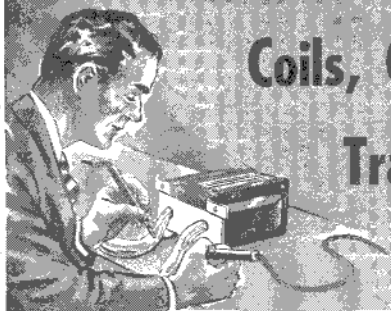
J.G., New Jersey



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**NATIONAL RADIO INSTITUTE
WASHINGTON, D. C.**

How To Test and Replace Coils, Chokes, and Transformers



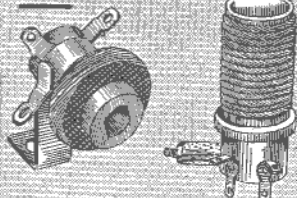
ALTHOUGH a number of coils (chokes and transformers) are used in radio receivers, they do not become defective nearly as often as condensers, tubes, and resistors. This is fortunate, because a replacement coil must often have exactly the same electrical characteristics as the original to operate properly; consequently, considerable care is necessary to order the right replacement. Since exact replacements are so frequently necessary, servicemen rarely carry in stock any great number of replacement coils. Instead, they order specific coils when replacements are needed.

Your Lessons in Radio Fundamentals have taught you much about how coils are made, and there will be more details in other Lessons. For now, we shall briefly review the types of coils, then shall go on to give you information about testing coils and replacing them.

Coil Types. All coils are made by winding copper wire on supporting forms. If there is no core material except the fiber, bakelite, wood, or cardboard form on which the coil is wound, we have an *air-core* coil; these are found in the r.f., oscillator, and i.f. stages of a superheterodyne receiver. If laminated strips of magnetic materials (iron, steel, or magnetic alloy metals) are used inside the form, the device is called an *iron-core coil* and will be found in the a.f. amplifier or power supply. (Some r.f. coils use powdered iron cores; however, air is still the major core material, so they are not called iron-core coils. You will find them referred to as "permeability-tuned" coils.)

TYPICAL COILS

R.F.



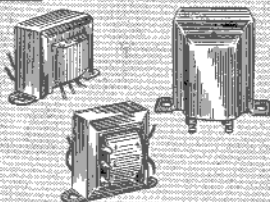
The r.f. coils shown in the illustration are "air-core" coils—wound on fiber forms that contain no magnetic materials. (They are sometimes also made with powdered iron cores.) R.F. coils are used in preselector and oscillator circuits.

I.F.



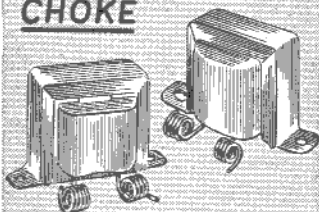
Two i.f. coils, wound on the same form, are shown in the illustration. The coils are inductively coupled, but have no actual wire connection between them. Some special-purpose i. f. transformers have three coils wound on a common form.

A.F.



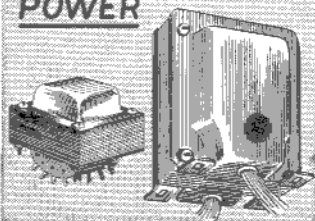
A.F. transformers were once commonly used for coupling between stages in the audio section. In modern home receivers, however, they are used almost solely as output transformers to couple the power output stage to the loudspeaker.

CHOKE



The iron-core chokes shown resemble audio transformers in outward appearance. However, each has only one winding—notice that there are only two leads from each. Transformers always have at least 3 leads, and usually 4 or more.

POWER



Power transformers like those shown normally have four windings—a primary winding, a high-voltage secondary winding (plate supply), a low-voltage secondary winding (filament supply), and a special low-voltage secondary winding for the filament of the power tube.

All these windings are classed as *coils*. If there is only a single winding on the form (or if there is no inductive coupling to another coil) the part is called a *choke*. When there are two or more windings *inductively coupled*, the part is a *transformer*.

COIL DEFECTS

In general, coils can have the same defects as other parts—they open-circuit, short-circuit, and change in value. Except for open circuits, coil troubles are not as easy to find with an ohmmeter as are similar troubles in other parts. However, there are definite clues in the manner in which the set operates; you will learn about these elsewhere in your Course.

Open Circuits. An open circuit in any kind of coil can be found by checking for continuity with an ohmmeter. The normal coil resistance is far less than that of ordinary shunting parts, so it is usually possible to check coils without unsoldering them. If you fail to find continuity between the terminals that you know should go to a continuous winding, then the coil is open. (If you get a higher resistance reading than you expect for the coil alone, it may be that the coil is open, and that you are measuring the resistance of the shunt part. In this case, unsolder the coil and check it directly.)

► A break in the wire is likely to be caused by a chemical action that eats through the copper wire—an action known as electrolysis. Also, with air-core coils, the form on which the coil is wound may be expanded enough by temperature changes to break the wire. (Such a break is generally near one of the terminal lugs to which the wire leads are connected.) In addition, it is always possible for the coil winding to burn out if excess current flows through it, although this is rather rare. When this occurs there is considerable likelihood that other parts are also defective.

Short Circuits. Short circuits may occur either between turns or between layers. (Many coils are wound in layers of turns.) The wire is insulated either with a silk or cotton covering or with enamel. If the covering frays, or the enamel flakes off, adjacent turns or

layers may touch. In iron-core coils, the heat produced by power losses in the core may eventually destroy the insulation and permit a short to occur. When this happens, excessive current will flow through the shorted turns and may eventually burn out the coil. And, of course, excessive current caused by any other trouble will overheat a coil and cause eventual damage if not corrected in time.

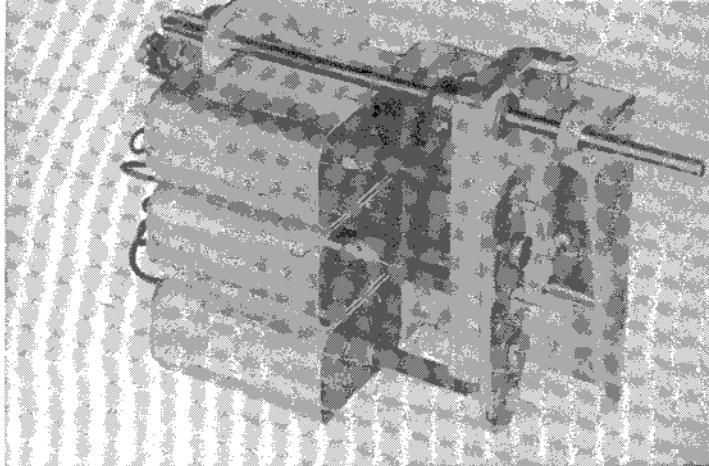
Short circuits between *adjacent turns* are hard to detect because the resistance of the coil is changed so slightly. For one thing, you will seldom know the exact resistance the coil should have; even if the value is given on the circuit diagram, it will be only an average value from which any specific coil may vary somewhat. Also, your ohmmeter will seldom be accurate enough to indicate whether the coil is a turn short, even if you do know what the exact resistance should be.

Power transformers or filter chokes become hotter than normal when a short circuit exists, but these coils run hot anyway. Unless you know exactly what the temperature should be, you can rarely judge whether there has been a slight increase.

► The operation of the receiver is almost the only indication that a short circuit between turns has occurred. Short circuits reduce the inductance and thereby affect the circuit action, either upsetting the tuning if the coil is in a resonant circuit, or, possibly, changing the fidelity of response if the coil is an audio transformer. (You will learn later how to recognize and check for these conditions.)

In a layer-wound coil having hundreds of turns, short circuits between *layers* are somewhat easier to detect, since there may be a fairly considerable change in the total resistance. However, the change is seldom so great that you can be sure a short circuit exists unless the operation of the receiver confirms your suspicion. It is rare indeed to find a coil that is completely short-circuited (near zero ohms), although this may occur if the terminal wires cross each other on their way to a terminal strip or to the connecting lugs.

In other words, two characteristics of a coil are



One of the permeability tuning units that are becoming increasingly popular in modern receivers. This unit is tuned by sliding the long bar on the top in or out.

changed when a short circuit occurs between turns—its resistance decreases and so does its inductance. Generally speaking, the decrease in resistance is too small to be readily detectable with an ordinary ohmmeter. However, the decreased inductance may have a considerable effect on the operation of the receiver, and, in most cases, you will have to rely on this to show you whether a short circuit has occurred.

Changes in Value. Short circuits are not the only reason why the inductance of a coil may change. A change in inductance may also be caused by a shift in the position of the coil turns or sections, particularly in r.f. and i.f. coils. You will rarely be able to tell whether the changed inductance is caused by shorted turns or by turns that have changed position. However, the cause of the inductance change doesn't matter—you'll have to replace the coil anyway if there is a change.

► Iron-core coils may at times develop leakage between the core and the coil. Leakage can be checked with an ohmmeter by disconnecting the coil in question from the circuit and measuring the resistance between one of its terminals and the core. A reading showing a resistance below 20 megohms indicates leakage, which usually means a new iron-core coil is required. You will learn later when to suspect leakage.

► The effectiveness of an air-core coil is reduced sharply if it develops a higher than normal a.c. resistance. As you know, a coil should have inductive reactance, but it should have a minimum of resistance in series with this reactance. A poor connection at a terminal, or a wire that is almost open (corroded through all but a slender section) will increase this series resistance and so reduce the Q of the coil. As you have learned in your Lessons on Radio Fundamentals, the lower the Q , the poorer the coil will be, particularly in a resonant circuit.

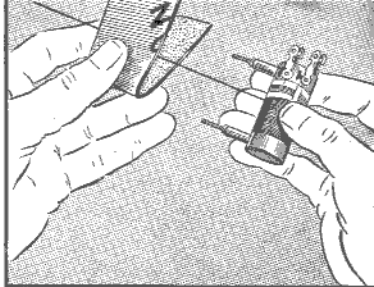
Coil Q may also be reduced by leakages along the coil form and by leakage through the insulation. Loss of Q may be a serious defect in a coil, but, unfortunately, it cannot be measured readily by service instruments. An ohmmeter will rarely show the losses that cause lowered Q nor will it indicate how these losses will affect the coil at the frequencies at which the coil is to be used. There are laboratory instruments with which Q can be measured, but these are not practical for service use.

You must, therefore, depend on the manner in which the receiver operates to show you whether the Q of a coil has become so low that the coil should be replaced. When coils lose their Q , the amplification of the receiver drops and so does the selectivity. There is increased interference from stations on adjacent frequencies, and the radio output is less than normal. As a bit of advanced information, the trimmer associated with a lowered Q coil will adjust much more broadly than normal.

Summary. Except for opens, your ohmmeter is not a reliable indicator of the condition of a coil. To detect troubles with coils, either you must eliminate all other possible suspects, or you must know how the circuits are supposed to operate and whether the observed defect in operation can be caused by a coil. You will gradually acquire this ability.

► Let's suppose that we have determined that a coil is defective, so that we can run through the steps of repair or of ordering the proper replacement. In the following discussion, we shall limit ourselves to r.f., oscillator, i.f., a.f., and power *transformers* and r.f., a.f., and power *chokes*. We shall not consider the speaker

FIG. 1. How to use sandpaper to remove insulation from a coil wire before soldering the wire to one of the coil terminals. For greater clarity, we have exaggerated the length of wire unwound from the coil in this illustration; normally, you should unwind as little as possible—an inch or so at the most.



field or the 'speaker voice coil, because these will be discussed in the RSM Booklet on Repairing Loudspeakers.

REPAIRING COILS

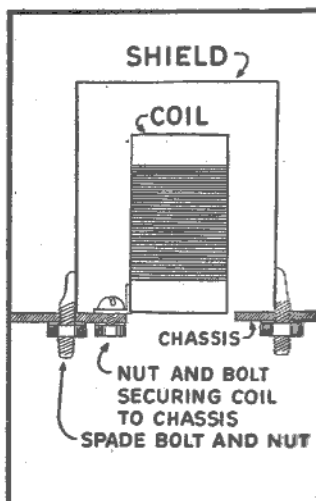
Open Coils. It is sometimes possible to repair an open coil. A break in an air-core coil is usually right at one of the terminal lugs, so examine the coil carefully. If you find a break, clean away the enamel insulation as shown in Fig. 1, then resolder the wire to the proper lug. If the wire is too short, solder a piece of fine wire to the lug and use the wire to splice the coil lead.

Often an r.f. or an i.f. coil will be in a shield can that has to be removed before the coil can be examined. Generally the shield will be fastened to the chassis by "spade" bolts that are permanently attached to the shield, as shown in Fig. 2. Use a socket wrench to remove the nuts from the bottom of the chassis, then lift the coil shield straight up and off.

In many i.f. stages, a connecting lead from the coil to the tube top-cap is run through the top of the shield. Sometimes the lead may be long enough to slip the shield up on it and thus expose the coil terminals. If not, the grid clip must be taken from the lead before the shield can be removed.

Look for green corroded spots on the windings. These are points where electrolysis is at work. If there is only one spot, you can scrape off the green corrosion and

FIG. 2. A typical shield and coil installation. Be careful not to bend the spade bolts when removing the shield.



make a good soldered connection. However, if there are a number of these green spots, a new coil should be installed because, even though you correct the present trouble, there will be more difficulty later.

After replacing or repairing a shielded coil, be sure to put back the shield properly. In the case of a shield with a grid lead through the top, you may have some difficulty in fishing the wire up through the hole. If so, run a length of thin wire through the hole in the top of the shield. Then, wrap or solder this wire to the grid lead and use the wire to pull the grid lead up through the hole as you push the shield down over the transformer. After you have fastened the shield in place, you can disconnect this extra wire and resolder the grid lead to the top cap clip.

► More difficulty is usually experienced in getting to the winding of iron-core coils, most of which are sealed in a shield container by a pitch compound. Because of the trouble involved in chipping this material away (or the messy process of melting it out), few servicemen try to make repairs on these coils, except in emergencies.

In any case, if the break is not visible or is not easy to repair, there is little point in wasting time on it as long as a replacement is readily available.

Low-Q Coils. If a coil has losses, go over the terminals with a hot soldering iron, leaving the iron in place long enough so that the solder on each joint will melt and flow. This will eliminate any high-resistance joints. If this does not clear up the trouble, however, moisture probably has been absorbed by the coil form, and it is usually necessary to replace the coil. (The coil

Courtesy Thordarson Electric Mfg. Co.

An iron-core choke. Chokes of this sort are still used in power supply filter systems of sets using p.m. speakers. In sets having electro-dynamic speakers, however, modern practice is to use the field coil of the speaker in place of a separate choke.



can sometimes be dried out in an oven set at low heat (200°), but the coil then must be dipped in a special moisture-proofing compound known as "coil dope" or else in melted wax. Even with this protection, the cure is seldom permanent; the coil will usually absorb more moisture soon.)

HOW TO ORDER REPLACEMENT COILS

Securing a proper replacement coil is no problem if the set manufacturer is still in business. Simply order an exact duplicate from the local distributor or directly from the factory; all you need to specify is the make and the model number of the receiver and the part number of the coil. You can find the part number in the service information supplied by the set manufacturer. If you do not have the part number, then the make and the model number of the set and the *function* of the part (that is, whether it is an r.f. transformer, i.f. transformer, filter choke, etc.) will enable the manufacturer to supply you with the proper replacement.

Of course, to tell the function of a part, you must know more about radio circuits than you have yet learned. However, we don't expect you to be replacing coils at this point in your servicing training, and, by the time you are, you'll have learned all the names of the parts found in receivers.

You can also get exact duplicate coils from coil manufacturers. These manufacturers issue catalogs in which you can look up the coil you want by the make and model number of the receiver and the part number of the coil and from these find the designation the coil manufacturer uses for this particular coil. Even if the set manufacturer has gone out of business, the coil manufacturers may have exact duplicate replacements for the "orphan" set. If not, they will wind you a new coil that is an exact duplicate of the defective one. Catalogs of these manufacturers indicate what information they need to wind you a new coil.

You should always use an exact duplicate when you replace an air-core coil if it is possible to get one. Air-core transformers are almost invariably used in some

form of resonant circuit. For this reason, it is important that the replacement for the tuned coil have exactly the same inductance as the original. Also, for the set to have the same amplification and selectivity, the Q of the coil must be near that of the original. The only way you can be sure of getting a replacement coil that duplicates the original in these important respects is to use exact duplicate replacements.

► Exact duplication of electrical characteristics is not quite as important with i.f. coils as it is with r.f. coils. For best results, you should use an exact duplicate i.f. coil if you can find one, but, if you cannot, coil manufacturers can supply so-called "universal" i.f. coils that will be satisfactory. You will have to specify the i.f. frequency to be used, and whether the transformer is an input, interstage, or output type.

► R.F. choke coils are not widely used today. If you do find a defective one in a broadcast band receiver, a coil with similar inductance will be a satisfactory replacement. However, if the choke is tuned (in a resonant circuit), then an exact replacement should be obtained. Also, you will have to be a little more careful to get an inductance match if the coil is used in a short-wave receiver.

► You will rarely find an iron-core choke or iron-core transformer whose inductance value is critical. For this reason, it is practicable to use less exact replacements for these devices. Manufacturers of iron-core coils issue "service guides" in which you can find suitable replace-

Coil manufacturers list their products in catalogs like these, from



ment parts if you know the make and model number of the receiver and the function of the part. It is also helpful to know the part number of the coil, but not usually necessary. It would be well for you to get these guides from the various manufacturers (they are usually either free or sold at a nominal price) or from a radio supply house.

These guides will show you the part number the coil manufacturer has assigned to the coil you want, and you can use this part number to order from him or from your usual parts supplier. The replacement coils you get by ordering this way are not usually exact duplicate replacements, but will be close enough in electrical characteristics to be usable. Sometimes you may find a considerable difference in physical size.

Universal replacements are also obtainable for iron-core coils. These are usually more satisfactory than similar replacements for air-core coils. We will say more about this later in this Booklet, when we discuss replacement of iron-core devices.

Of course, you need not look up part numbers of replacement coils in your manufacturer's catalog unless you wish to do so. You can always take the necessary information (make and model number of the set, function of the part, and, if possible, part number of the coil) to your supply house where they will do the looking up for you, and supply you with the closest available replacement or order a specially-wound coil for you if you prefer. Mail order supply houses will also give this service.

which you can find a replacement for almost any defective coil.



Now let's see what should be done to replace defective coils.

HOW TO REPLACE AIR-CORE COILS

If you have obtained an exact duplicate replacement, all you need to do is to remove the old coil and mount the new one in its place. To be sure you make the proper electrical connections, don't disconnect the original coil until the replacement arrives. Then, make yourself a picture diagram or sketch like that shown in Fig. 3, showing the position of all the leads before you remove them.

An r.f. coil is likely to be located in a place that is hard to reach. For this reason, it is sometimes desirable to clip the lugs off the defective coil rather than to remove the leads themselves. Then, when the new coil is in place, you can solder the old lug (with the leads attached) onto the proper lug of the new coil, if you find it too difficult to remove the cut lugs from the leads.

Most i.f. transformers come with leads instead of lugs. In such cases, don't cut the leads of the defective unit too short. Instead, it is best to cut the leads so that an inch or two of each remains connected in its circuit. These short wires will allow you to determine the color of the leads fastened to different points and also will help to indicate the place of connection. You can remove these short leads as you solder each new wire in place.

I.F. transformers come with shields of various sizes. If you are not using an exact duplicate, try to get one the same size as, or smaller than, the original. If the replacement does not fit the mounting holes of the old

coil, it will be necessary to drill new mounting holes on the chassis. Mark on the chassis the positions of the shield bolts and, if necessary, the position of a hole through which the leads can

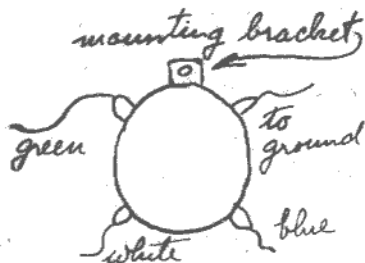


FIG. 3. Before removing a coil, make a rough sketch like this to show the proper connections.

pass. Then examine beneath the chassis to be sure that, when the drill goes through, you will not drill into some part. After moving any such part out of the way, and preferably removing tubes to safeguard them, you can proceed to drill the new hole or holes.

Any general-purpose replacement i.f. transformer will be adjusted at the factory to approximately the right i.f. frequency. However, when it is installed in a receiver, stray capacities between wires and between parts will not be compensated for, so the adjustment will not give the best results. For this reason, the receiver should be realigned, (in accordance with the instructions you will be given in a later RSM Booklet) whenever an i.f. or r.f. transformer is replaced.

REPLACING IRON-CORE CHOKES AND AUDIO TRANSFORMERS

Iron-core choke coils are commonly used as filter chokes, and occasionally as a.f. chokes in inductively coupled circuits. It is, of course, best to use exact duplicate replacements or one of the replacements recommended by the coil manufacturer whenever possible. However, if you can't get one of these, one of the universal replacement types will generally be satisfactory.

To use a universal replacement, you must know the function of the choke, the inductance value, and the current rating. In the case of certain filter chokes, the resistance value may also be of importance. By "function of the choke," we mean the position the choke occupies in the circuit. As an example, a filter choke may be either an input or an output choke; one coupling choke may be used in the plate circuit of a stage, and another may be used in the grid circuit. (You may not exactly understand these terms now, but you will learn their meaning shortly. In the meantime, remember that the name "choke" may not be enough identification.)

If you have plenty of time, and want as exact a duplicate as possible, you can have your supply house send the choke to a coil manufacturer who can duplicate it. If you do not wish to wait this long, you can often find

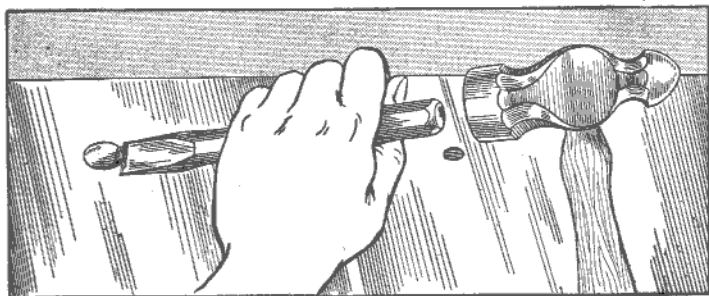
a satisfactory replacement just by specifying the type of set. For example, in receivers using a power transformer, the filter choke will usually have an inductance of 8 or 10 henrys and will be rated at 60 to 100 ma. Any choke meeting these specifications will probably work well enough. A.C.-D.C. receivers, which do not use a power transformer, are so much alike that you can ask for an "a.c.-d.c. filter choke" and will get a satisfactory replacement for most receivers of this kind.

► When you start to install the new choke, you may find that the original choke is riveted to the chassis. This means you must cut the rivet, as shown in Fig. 4. You do not need to use rivets to fasten the replacement, however; ordinary bolts and nuts will be satisfactory. If the replacement choke is of different physical size than the original, you may find it possible to use one of the original mounting holes and thus be required to drill only one hole. Again, be certain you will not damage any radio part underneath the chassis when you drill through.

Audio Transformers. There are a number of styles of audio transformers, as shown in Fig. 5. Each is named according to its use, which you will study in your Lessons on Radio Fundamentals.

Although interstage and input push-pull audio transformers are not used in many modern receivers, they were widely used in the older receivers that still come in for service. If you cannot identify the receiver sufficiently to get exact duplicate replacements, ordinarily you can use general-purpose replacements. Interstage

FIG. 4. Here's how to remove a rivet from a chassis.



transformers "amplify" the signal according to the ratio of the number of turns on the two windings. However, replacements rated at 2-to-1, 2½-to-1, or 3-to-1 will all prove satisfactory in most cases.

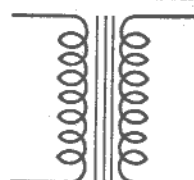
► Output transformers are found in all modern receivers, and they frequently become defective. If you cannot obtain an exact duplicate output transformer, then one of the universal types can be used. These have a secondary winding with a number of taps on it, so that the proper taps can be chosen to match the loudspeaker to the output tubes. Again you must know something about radio to make the proper replacement, because you have to know the characteristics of the output tubes and should know the voice coil impedance of the loudspeaker. However, if you do not have exact information, the instructions which accompany universal transformers will give directions for choosing the proper secondary terminals.

There are a number of other audio transformers; some have extra windings, and others are for special purposes. You will learn about these in your Course, and will then be in a better position to make a replacement when duplicate transformers are not available.

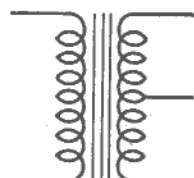
HOW TO REPLACE POWER TRANSFORMERS

Power transformers develop the same troubles as do other transformers. However, it is usually easier to locate a defect in a power trans-

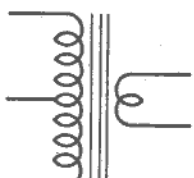
TYPES OF AUDIO TRANSFORMERS (SCHEMATICS)



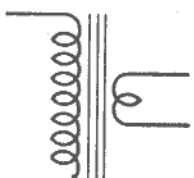
INTERSTAGE



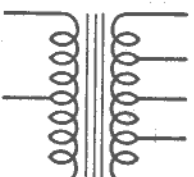
INPUT
PUSHPULL



OUTPUT
PUSHPULL



OUTPUT



UNIVERSAL
OUTPUT

FIGURE 5

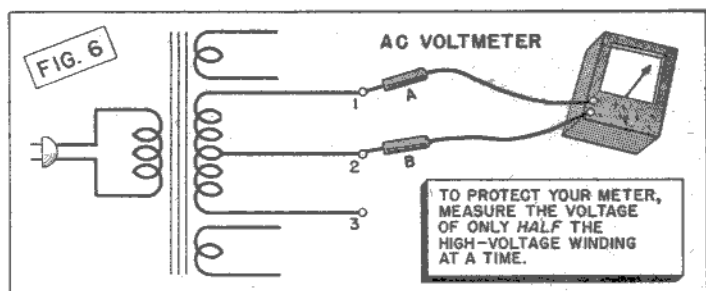
former, for frequently there are direct clues to what is wrong. For example, an open primary winding on the power transformer will cause the receiver to be completely dead and there will be no illumination of tube filaments or of pilot lamps. If one of the low voltage secondary windings opens, then the tube filaments connected to this winding will not be energized, and these tubes will be cold. If the high voltage winding opens there will be no B supply voltage, and, although the tubes will light, the receiver will be completely dead.

If the radio is completely dead, and there are no pilot lamps or tubes lighted, be sure to check the wall outlet before condemning the power transformer. The best way to do this is to plug in a floor lamp to be sure that electricity is available.

► You can check the power transformer with an ohmmeter, provided you follow the safety rule of unplugging the power cord from the power outlet.

You can also measure the voltage delivered by the various windings with an a.c. voltmeter. (The transformer must be connected to the power outlet and the receiver must be turned ON when making voltage measurements.) Be careful about measuring the voltage of the high voltage winding. Test only one-half the winding at a time as shown in Fig. 6. To check the other half of the winding move the voltmeter probe A from terminal 1 to terminal 3, leaving B on 2.

► No test instruments are necessary to identify a power transformer that is overloaded. Your nose, ears, and sense of touch will provide all the evidence required. Engineering design and the underwriters requirements limit the normal temperature rise of a power transformer to about 72° Fahrenheit. As room temperature is normally in the vicinity of 77° Fahrenheit, a transformer should not exceed the sum of these, or about 150°, which is considerably below the boiling point of water. This temperature will not cause a sensation of burning when the hand is placed upon the core of a transformer, but, if the transformer is overheated, it will be too hot to handle comfortably. When the transformer overheats, the insulation between windings and



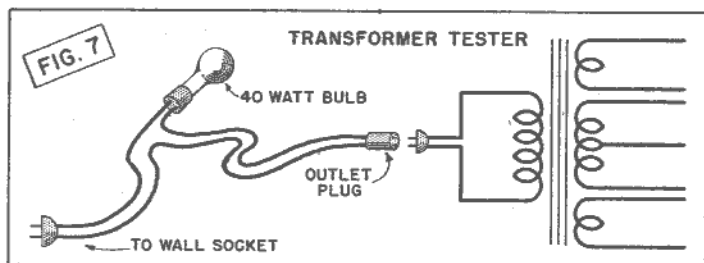
between layers will burn slowly (char), producing a smoke with an unpleasant, irritating smell. Sometimes the sealing compound boils, producing a sizzling sound. When this condition is found, don't leave the power transformer connected to the power line. If you create too much smoke, the resulting disagreeable odor remains a long time.

This overload condition is caused by an excessive power demand that may be the result of trouble in some circuit connected to the transformer or may be caused by a short circuit within the transformer itself. Regardless of the source of trouble, charred insulation is conductive, and short circuits will develop within the transformer (if not already there) if the overload is allowed to continue.

► Since the transformer may not yet be damaged, it is necessary to make a test to determine whether the overload is due to external causes. To do this, remove *ALL* tubes from the radio, then turn it back ON to see if the transformer still overheats.

If the transformer heats up and smokes when all tubes are removed from the receiver, then it is probably defective or has been damaged, although there still exists the possibility of a short circuit between some of the leads coming from it. On the other hand, if the transformer eventually cools with all the tubes out, there may be an overload condition in the radio and the transformer may not yet be damaged. If the defect is found and corrected, then it may not be necessary to replace the transformer.

A simple test rig is sometimes used as a time saver in testing for short circuits within a transformer. Fig. 7



shows the circuit. Connect a 40- to 60-watt light bulb in series with the primary in the manner shown, and remove all the tubes from the receiver. When the receiver is plugged in and turned on, the light should be very dim, or there should be no light at all. If there is a short circuit within the transformer or in the wiring to the transformer, the lamp will light brightly. No further tests are necessary except to examine the leads from the transformer to be sure that the secondary leads have good insulation, and that no bare wires are allowed to touch.

► Let's assume that the transformer is defective or has been damaged by an overload. (If there is an overload condition, it must be corrected *before* the replacement is installed.) Again it is desirable to obtain an exact duplicate replacement part. Not only will the replacement then have exactly the same characteristics as the original, but also it will be the same physically. This means all connecting leads and lugs will be in exactly the same places, which simplifies the replacement considerably. Even so, it is best to make a sketch showing the connections before disconnecting the defective transformer.

If a duplicate is not obtainable, you may be able to find an equivalent transformer listed for the make and model of the receiver, in catalogs of transformer manufacturers. If not, a universal replacement will be satisfactory if you are careful to order one with the proper ratings. You will seldom have to compute current or voltage ratings (though you will learn how to do so in a later lesson); usually a list of the tubes used in the receiver will be all you'll need to find a suitable replacement in manufacturers' catalogs. Of course, you will

have to be sure the replacement has the proper number of secondary windings.

Although it is perfectly all right to use a replacement transformer that is larger physically than the original, be sure the replacement won't be too large to fit the available space. Check the cabinet space in midget receivers to be sure the replacement will not prevent the receiver from going into its cabinet. If the original transformer was placed in a hole or "window" in the chassis, you will have to obtain a replacement to fit that space or else figure out another way of mounting the replacement on top of the chassis.

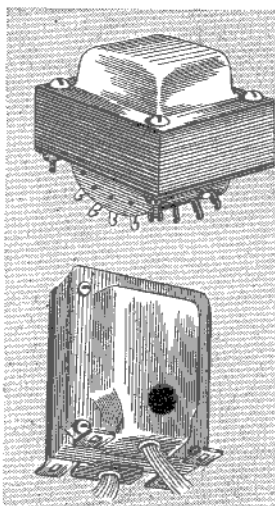
Replacement transformers come with universal mounting brackets, which make it possible to mount them in practically any position on the chassis.

Some transformers have lugs; others have leads. As long as the proper connections are made, these types can be considered interchangeable. Both are pictured in Fig. 8. Naturally, a replacement transformer may be different from the original in the color code of its leads or in the position of lugs. On standard replacements, the leads are identified by the instructions packed with the transformer so you won't have much trouble in identifying them. However, you have to be able to read the circuit diagram and to make the proper connections. This will be an easy task when you have progressed further in your Lessons on Radio Fundamentals.

► Most power transformers have two primary leads; three high voltage leads (including the center tap); two filament leads for the rectifier tube; and two filament leads for the other tubes. In addition, there may be an extra filament winding, or there may be a center tap on one of the filament windings.

In general, replacement transformers will have a center tap

FIG. 8. The transformer on top, called a half-shell type, mounts in a hole in the chassis. The other mounts on top of the chassis.



lead for the tube filament windings. If this lead is not used in the receiver connections, cut it to about two inches long and wrap the end with tape to prevent it from shorting to anything. If an extra secondary winding is on the replacement transformer, just tape up its leads individually so that they cannot short to each other, and ignore them.
